IURC ELECTRIC SERVICE QUALITY RULEMAKING PQ DATA REQUEST
Indianapolis Power & Light Company Response
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1. **From a customer's perspective, how are power quality problems usually described/identified, i.e. what does the customer complain about?**

Customers typically describe and identify Power Quality (PQ) problems in very basic terms such as spike, glitch, flicker, power surge, blink on/off, wavy, noise, bright lights, dim lights, interference, etc. During the investigation process with the customer, an IPL representative will listen and translate the customer problem description into a PQ category with a more specific electrical definition.

2. **Are the complaints and/or problems different for residential or small commercial customers versus large commercial or industrial customers? If so, please explain how the complaints are different.**

Customer complaints are both similar and different for small and large customer classes due to numerous reasons as explained below:

<u>Momentary Interruption</u>
All residential, most commercial and small industrial customers are fed from the IPL radial distribution system. These customers complain the most about momentary interruption because of the possible disruption of their process. All customers on a distribution circuit momentarily lose power during this type of event due to the radial configuration of the system. Significantly more momentary interruptions occur on the distribution system compared to the transmission system due to the increased number of distribution circuits, circuit exposure and circuit length. Medium to large size industrial customers are fed from the transmission system and experience few, if any, momentary interruptions due to the network configuration of the system. The loss of a transmission line may not affect any medium to large size industrial customer or could just affect one or a few customers. Also, fewer momentary interruptions occur on the transmission system compared to the distribution system due to electrical service generally provided by dedicated transformers and/or substations and the spacing and clearance requirements for high voltage overhead construction specified in the National Electric Safety Code.

<u>Poor Wiring and Grounding Practices</u>
Poor wiring and grounding practice is a leading cause of customer complaints that transcend customer classification. Poor wiring and grounding practice can be associated with various PQ categories. Some examples of customer complaints due to wiring and grounding are:

- Simultaneous over and under voltages that can be an indication of an open neutral condition in customer wiring or utility service entrance cables. In this situation, the customer may complain about bright and dim lights and intermittent operation of equipment. An extended overvoltage condition associated with an open neutral condition is very dangerous because a fire can start from equipment failure.

- Loose connections and defective main breakers in customer facilities can result in dim/partial lights, transients, momentary interruptions and/or flickering light events. In this situation, the customer may complain about dim, partial and flickering lights and intermittent equipment operation.
- The use of shared circuits in customer facilities versus dedicated circuits for certain types of loads can result in incompatible equipment operation. In this situation, the customer may complain about equipment malfunction while another machine is starting or operating.
- Multiple ground problems in customer facilities can be associated with transients, voltage sags and swells, and voltage fluctuation events. In this situation the customer may complain about equipment failure including component PC type boards. Multiple grounds can cause equipment failure during lightning events or faults on the power system. Customers with older facilities are more likely to have multiple ground points.

Voltage Sags and Undervoltage

Generally, faults on the power system result in voltage sags and undervoltage events. Power system faults cause the voltage to drop to near zero at the fault location for a period of time. Switching large loads or starting large motors can also cause the voltage to sag. These events may cause a malfunction of customer equipment due to a dip in voltage over a time period. The sensitivity of customer equipment to a voltage sag depends upon the fault location relative to the customer location, fault type, fault duration, fault current, fuse size for distribution faults, instantaneous or fast tripping philosophy, customer ride-through capability, customer equipment design, selection and manufacturing, etc.

For the IPL radial distribution system, voltage sags can affect residential, commercial and small industrial customers on one circuit due to a fault on an adjacent circuit that are both fed from the same substation transformer. Typically, five distribution circuits may be connected to one substation transformer. Thus, a customer on one circuit can be affected by faults and subsequent voltage sags on one of the four adjacent circuits. More voltage sag events occur on the distribution system compared to the transmission system due to the significantly greater number of distribution system faults. As a result, commercial and small industrial customers fed from the distribution system complain more about voltage sag events than medium to large size industrial customers fed from the transmission system. Customers may complain because of the possible disruption of their processes during a voltage sag event.

A fault on the IPL transmission system can have widespread affects from voltage sags on all customer classes due to the network configuration of the system. All customers are eventually connected to the transmission system through distribution facilities. Fortunately, the number of customer complaints is significantly less because there are fewer faults on the transmission system compared to the distribution system.

Electromagnetic Interference
Electromagnetic Interference (EMI) can be caused by damaged equipment and eminent failure of equipment, such as lightning arresters, overhead conductor strand damage due to lightning strikes, etc. In this situation, customers may complain about interference with radio and television signals. EMI has the greatest affect on residential customers but can affect all customer classes.

3. What steps does your utility take to address power quality complaints?

The IPL approach to address PQ problems is to work cooperatively and proactively with customers, other utilities, industry standards groups and/or equipment manufacturers. This approach typically results in economical solutions to customer power quality complaints and problems. For example, the best options to address customer momentary interruption complaints may be the installation of mitigation equipment by the customer, the removal of fast tripping on distribution circuits by the local utility or working with industry standards groups to affect the design and manufacture of the equipment itself. In some cases, the most effective solution may already be known due to past experience and investigations.

The specific steps taken by IPL to address PQ complaints are contained in the IPL PQ program which typically includes the following:

- Problem identification;
- Monitoring of electrical facilities on either side of the revenue meter;
- Suggested plans and actions for the customer, utility and/or equipment manufacturer;
- Advice on possible solutions;
- A referral list of equipment suppliers and contractors;
- Leaflets for customers on common PQ problems;
- Customer education including seminars; and
- Advice for contractors contained in the IPL Electric Service and Meter Manual.

4. Does your customer call center categorize power quality complaints separately?

- **If so, how many power quality complaints has there been in the last 12 months? How were these complaints resolved?**
- **If not, please estimate how many power quality complaints there has been over the last 12 months and how they were resolved.**

The estimated number of complaints recorded by the IPL Power Quality Group over the last 12 months is summarized below:

Code	Category	Number
125	Transient	4
126	Swell and Overvoltage	24
127	Sag and Undervoltage	19

128	Over/Under Voltage (Neutral Problem)	32
129	Flicker	79
130	Interruption (Momentary < 2 min)	255
131	Interruption (Temp)	0
132	Interruption (Outage > 2 min)	23
133	Phase Unbalance	3
134	Harmonics	4
135	Noise & Interference (Ground or Wiring)	9
136	Electromagnetic Interference	94
137	Electrostatic Discharge	3
138	Other	27
	Total	576

Customer complaints were typically resolved by following the IPL PQ program steps identified above. The specific solutions to customer PQ complaints have occurred in numerous ways. Some examples include:

- providing customer information on IPL system design and operation;
- providing educational leaflets on "Solutions for Power Quality Problems in the Home" or "Why Does My Power Blink On and Off";
- providing suggestions for the purchase of PQ mitigation equipment by the customer;
- providing a Referral List of PQ engineers, contractors and manufacturers for customer use;
- providing a historical record of current and past events;
- providing results from monitoring PQ problems with IPL instrumentation;
- conducting maintenance on IPL facilities;
- completing a tap change to the customers service transformer; etc.

5. Are there actions customers can take to insulate their equipment from power quality problems? If so, please explain what actions could be taken.

The first step customers can take to insulate their equipment is to contact the local utility and/or visit utility web sites for more information on typical problems and solutions. There is a significant amount of free information provided by utilities for the benefit of customers with PQ problems. IPL provides free advice on PQ problems and solutions including protection of customer equipment and selection of the proper equipment to solve a PQ problem. For example, the selection of the proper Uninterruptible Power Supply (UPS) equipment to solve momentary and sustained interruption events has been a high source of confusion for customers. A UPS insulates customer equipment from interruption events. Customers have frequently selected the wrong type of UPS for the application. There are three general types of

UPS provided by manufacturers which are Online, Offline and Line Interactive equipment. Due to cost, lack of knowledge, etc., customers often select Offline UPS when Online UPS is generally the right choice to solve the problem. Another source of confusion for the customer may be popular electronics stores that feature Offline UPS equipment. Utilities can also recommend qualified contractors to address specific customer power quality problems.

There are numerous trade magazines that feature articles on PQ problems and solutions. The Electric Power Research Institute offers in depth programs and information on Power Quality.

For customers with a technical or engineering background, the Institute of Electrical and Electronics Engineers (IEEE) has excellent standards, references and publications on this subject. For Example, IEEE Std 1250 entitled, "IEEE Guide for Service to Equipment Sensitive to Momentary Voltage Disturbances" contains a section on customer side solutions. Table 5 of IEEE Std 1250 entitled, "Power Conditioner Comparison" contains a list of typical solutions, relative cost, outage ride through capability and ranks the protection provided for various PQ solutions.